U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1426

FARM PLUMBING

PLUMBING TODAY consists largely of assembling and installing manufactured products. It requires less of the skill of the old-time lead worker and more practical knowledge about house water supply and house drainage. The modern plumber must know what materials, pipes, and fixtures are most appropriate, how they may best be installed, and what they cost. Five to ten percent of the cost of a fully equipped house is for the plumbing, an expense that justifies full study and information.

This bulletin is for the farmer plumber and for those who desire to follow the work on which a regular plumber is employed. Not all the conveniences that are desired need be installed at one time, but the work should always be planned in advance in order to obtain the best arrangement at the lowest cost. A sink will naturally come first, but the plumbing should include at least a bathroom. A small spare room or closet can often be converted into a bathroom and so contribute greatly to the convenience, comfort, and health of the whole family. The costs given herein are approximate retail prices quoted by dealers or manufacturers, without allowance for freight, and are subject to considerable variation according to the locality and the size of the order.

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FARM PLUMBING

By George M. Warren, *Associate Hydraulic Engineer, Division of Structures, Bureau of Agricultural Engineering*

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FEW THINGS contribute more to the convenience and comfort of the farm home than does good plumbing. How much it contributes to health and longer life none can say, but certainly it does much to lighten the work of the farm housewife.

The United States has better plumbing than any other nation, but its extension to farm homes has lagged far behind its use in the city. The 1930 census reports 994,202 of the 6,288,648 farms in the United States as having water piped into the dwelling. This is approximately 16 percent and means that 5,294,446 farms, or 84 percent, had little or no plumbing.

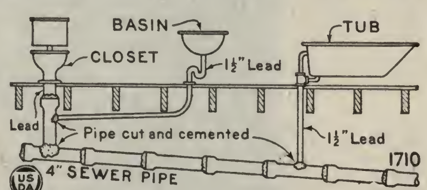

Figure 1.—Plumbing fixtures poorly connected. The bathtub has no trap; the basin trap is subject to self-siphonage and is forced by bubbles of sewer air when the water-closet is flushed; cutting into vitrified sewer pipe makes rough, leaky, easily obstructed joints and is a poor substitute for branch fittings.

The present tendency is toward simple, direct, standardized plumbing that combines the greatest usefulness with the lowest cost. Plumbing shops on wheels are rendering quick service in many localities. Local and State plumbing regulations should be studied and the work must conform to them. Fixtures should be in keeping with the surroundings and the pocketbook; simple unornamented white fixtures are generally preferred. If possible plumbing showrooms and shops should be visited, and the advice and prices obtained from manufacturers, dealers, plumbers, or mail-order houses. Many farmers have the skill and tools needed to do reasonably good home plumbing, but generally the services of a reliable plumber are recommended. Examples of home plumbing are shown in figures 1 and 2.

WATER PIPES

LEAD

Lead pipe is much used underground because it is durable and easily laid, but it should not be used for conveying acid waters or those of swampy or peaty origin. Even hard, feebly active waters, if they remain long in contact with lead, may dissolve amounts sufficient to produce serious cumulative effect. Therefore water that has stood overnight in lead pipe should not be used for drinking or cooking.

For low and medium working pressure up to 25 or 30 pounds per square inch, lead pipe classed A or S (strong) is suitable; for pressures up to 50 or 60 pounds, AA or XS (extra strong) should be used. Table 1 gives the weight and cost of strong lead pipe.

FIGURE 2.—Home plumbing in Maryland installed by one man unaided; no trouble from frost in 15 years because the faucets do not drip; water pipes are inside. Outside soil stacks are unsightly, but are often installed in mild and moderate climates such as those of Southern States.

TABLE 1.—*Weight and cost of strong lead pipe*

Weight and cost	Size of pipe (inches)						
	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2
Weight per foot......pounds..	1 1/2	1 1/2	2 1/2	3	4	4 3/4	6 1/2
Cost per foot......cents..	15	15	25	30	40	48	65

WROUGHT AND CEMENT-LINED

Standard-weight galvanized (zinc-coated) wrought pipe, either steel or iron, is generally used for farm water piping. It comes in various lengths, averaging about 20 feet, with ends threaded and carrying one coupling per length. To obtain genuine wrought-iron pipe it is necessary to specify such pipe in ordering.

To prevent the rusting of wrought pipe New England water departments have for many years lined their service pipe with cement, and such pipe is meeting with increasing favor in other localities. Sufficient mineral matter may be dissolved from the cement of new pipe to considerably increase the hardness and alkalinity of the water and render it more or less objectionable. These effects gradually disappear and are not regarded as of hygienic importance. Table 2 gives information on wrought and cement-lined pipes.

TABLE 2.—*Information on standard-weight galvanized wrought-iron and steel pipes, and cement-lined black and galvanized steel pipes*

Nominal size (inside diameter)	Outside diameter	Threads per inch	Nominal weight		Cost per foot			
			Galvanized	Cement-lined	Galvanized iron	Galvanized steel	Cement-lined black steel	Cement-lined galvanized steel
	Inches	*Number*	*Pounds*	*Pounds*	*Cents*	*Cents*	*Cents*	*Cents*
⅜ inch	0.675	18	0.57		10	6		
½ inch	.840	14	.85		10	6		
¾ inch	1.050	14	1.13	1.3	12	8	11¼	14¼
1 inch	1.315	11½	1.68	1.9	17	11	16¼	20
1¼ inches	1.660	11½	2.28	2.5	23	14	22	27¼
1½ inches	1.900	11½	2.73	3.0	27	17	26½	32½
2 inches	2.375	11½	3.68	4.1	36	23	35½	43¾
2½ inches	2.875	8	5.82	6.6	60	36	50¼	58½
3 inches	3.500	8	7.62	8.3	78	48	65¾	76½

COPPER AND BRASS

Seamless copper tubing and seamless copper and brass pipes (iron pipe sizes abbreviated I.P.S.) are meeting with much favor. They have long life and their cost is moderate. It is believed that copper or brass pipe can be used with assurance for conveying all ordinary waters. Although the amount of copper dissolved from pipes in ordinary daily use is extremely minute, it is well, with all kinds of pipe, to waste the so-called "stale" water that has stood long in the pipe. Table 3 gives information on copper and brass piping.

CAST IRON

Bell and spigot cast-iron pipe, coated with hot coal-tar pitch varnish, is obtainable in various sizes and strengths and is desirable for underground work because of its long life and the ease with which considerable deflection can be made at each joint. Pipes with prepared or foundry-made joints, of which there are several kinds, are desirable for farm use because there is no lead to melt and pour and the time and cost of laying them are reduced. Table 4 gives information on cast-iron water pipe having the more common types of prepared or bolted joint.

TABLE 3.—*Information on copper service tubing and standard-weight copper and red-brass pipes (I.P.S.)*

Kind of pipe	Nominal size	Outside diameter	Wall thickness	Nominal weight per foot	Cost per foot
	Inches	*Inches*	*Inch*	*Pounds*	*Cents*
Copper service tubing	3/8	1/2	0.049	0.27	9
	1/2	5/8	.049	.34	11
	3/4	7/8	.065	.64	16
	1	1 1/8	.065	.84	20
	1 1/4	1 3/8	.065	1.04	24
	1 1/2	1 5/8	.072	1.36	31
Copper	3/8	0.675	.091	.64	12
	1/2	.840	.108	.96	17
	3/4	1.050	.114	1.30	21
	1	1.315	.127	1.83	30
	1 1/4	1.660	.146	2.69	44
	1 1/2	1.900	.150	3.20	52
Red brass	3/8	Same as copper.	Same as copper.	.63	13
	1/2			.94	18
	3/4			1.27	23
	1			1.79	32
	1 1/4			2.63	47
	1 1/2			3.13	56

TABLE 4.—*Information on cast-iron pipe for 150 pounds working pressure*

Type of joint	Nominal size	Outside diameter	Wall thickness	Approximate weight per foot	Laying length	Cost per foot
	Inches	*Inches*	*Inch*	*Pounds*	*Feet*	*Cents*
Bell and spigot prepared for calking	1 1/4	1.75	0.19	4	5	17
	2	2.50	.25	6	6	21
	3	3.66	.31	11 1/2	6	30
	4	4.80	.34	16 1/2	12 or 16	34
Tapered, machined male and female ends with lugs and two bolts, nuts, and washers	2	----------	.25	6 1/2	6	16 1/2
	3	----------	.30	11 1/4	6	28
	4	----------	.31	16	6	36
Male and female ends with ring collars, stuffing-box ring gasket and bolts	2	2.38	.22	6	5	33
	2 1/2	2.88	.28	8 1/2	5	37 1/2
	3	3.50	.30	11	5	40
	4	4.80	.34	16	12 or 16	45

To prevent rust tubercles that impede flow, pipe in the sizes given in table 4 may be lined with cement at additional costs averaging 10 percent. The first and last listed types of pipe may be obtained in longer laying lengths, the intermediate joints being screwed or welded at the foundry. Figure 3 shows some of the water pipes described.

DRAINAGE AND VENT PIPES

CAST-IRON SOIL PIPE

Extra heavy cast-iron soil pipe coated with hot coal-tar pitch varnish and having hub and spigot joints is generally used for soil stacks and all underground lines except the house sewer. The latter is usually vitrified clay or concrete sewer pipe, and information on grading, laying, and jointing is given in Farmers' Bulletin 1227, Sewage and Sewerage of Farm Homes. Standard-weight cast-iron soil pipe is sometimes used on farms, but because of its lightness is more likely to be broken during shipment, handling, cutting, and calking. Table 5 gives information on both classes of pipe in single hub, 5-foot laying lengths.

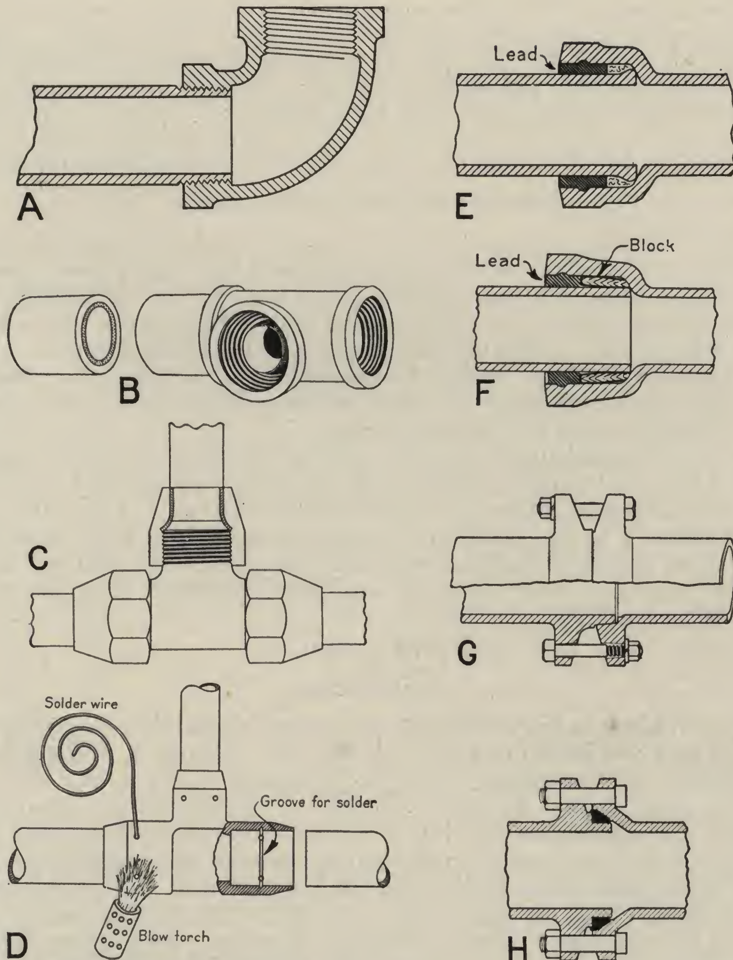

FIGURE 3.—Water pipes and typical joints: A, standard wrought pipe and elbow; B, cement-lined wrought pipe and lead-lined T-branch; C, copper service tubing and union T-branch; D, copper tubing and threadless T-branch with sweat-solder joints; E, common bell and spigot cast-iron pipe; F, bell and spigot pipe prepared for top calking in the trench; G, cast-iron pipe and machined bolted joint; H, cast-iron pipe and bolted joint with rubber-ring gasket.

TABLE 5.—*Information on cast-iron soil pipe*

Class	Size (inside diameter)	Wall thickness	Hub		Weight per 5-foot length	Cost per foot
			Inside diameter	Depth		
	Inches	*Inch*	*Inches*	*Inches*	*Pounds*	*Cents*
Standard	2	1/8	[1]	[1]	18	16
Do	3	1/8	[1]	[1]	26	22
Do	4	1/8	[1]	[1]	35	29
Do	5	1/8	[1]	[1]	45	36
Extra heavy	2	1/4	3 3/16	2 1/4	27 1/2	21
Do	3	1/4	4 3/16	2 1/2	47 1/2	32
Do	4	1/4	5 3/16	2 3/4	65	43
Do	5	1/4	6 3/16	2 3/4	85	55

[1] Approximately same as for extra-heavy pipe.

WROUGHT

Within buildings and aboveground, soil, waste, and vent pipes may be standard-weight galvanized wrought (either steel or iron) as listed in table 2. However, the general practice is to use cast iron for soil stacks and for waste lines larger than 2 inches and to use wrought pipe for waste and vent lines from 1¼ to 2 inches in diameter.

CORROSION AND LIFE OF PIPE

Pipe and fittings are made thicker than is required to sustain water pressure. This is to guard against corrosion and the strains caused by cutting, threading, and joining pipes and by the expansion and contraction of pipe lines. All waters and soils corrode, the action being particularly noticeable at threaded joints in wrought pipe. The results are "red water", reduced capacity, and shortened life. Sometimes the bore is clogged or closed with a rusty coating or deposit long before the pipe wall is destroyed.

Ordinarily, small black wrought pipe in the ground should last 10 to 20 years; galvanized steel, 15 to 30 years; galvanized wrought iron, 20 to 40 years; lead and cast iron, 40 to 75 years. It is, however, not uncommon to find lead and cast-iron pipes sound after 80 to 100 years, and, except for slight external corrosion, cement-lined black wrought pipe has been found in excellent condition after 40 to 60 years in the ground.

PIPE SIZES

WATER PIPE

A ½-inch kitchen faucet (inlet 0.53 inch and outlet 0.48 inch) tapped into the side of a barrel of water 2.3 feet from the top, is under a head of 1 pound and discharges, when fully opened, 3 gallons per minute; under a head of 11.5 feet or 5 pounds it discharges 6½ gallons per minute. A reasonable service in an ordinary home requires discharges of not less than 3 gallons per minute for each faucet (or valve) at a sink, washstand, bathtub, water-closet tank, and small shower head, 5 gallons per minute for a sill cock, and 10 gallons per minute for the three usual bathroom fixtures. Seldom are all of these fixtures used at one time. On average days the maximum draft for a family of six may not exceed 10 or 12 gallons per minute, but for short periods fixtures may be used in such combinations as to draw 15 to 20 gallons per minute.

A service pipe should be large enough to deliver the probable maximum draft to the central point of use, usually the bathroom or kitchen sink, and still leave from 1 to 5 pounds pressure on the highest faucet. The problem of how large the service pipe should be can be readily solved by a little study and the use of the diagram and directions given in figure 4. The diagram assumes that all the head is used to overcome friction within the pipe and that the water emerges full bore of the pipe and practically without pressure. Before applying the diagram to find the discharge of a pipe restricted by a faucet at the outlet, several feet should be deducted from the head to allow for friction losses within the faucet. This allowance for an ordinary ½-inch kitchen faucet may vary, as indicated above, from 2.3 feet (1 pound) for a fair flow to 11.5 feet (5 pounds) for a strong flow.

If the flow is from a hydropneumatic tank or street main, the equivalent head is 2.3 feet per pound of gage pressure, plus the vertical height of the tank or main above the faucet, or minus the vertical distance that the tank or main is below the faucet. Elbows and valves retard flow slightly, but this loss of head in fairly direct service lines can usually be disregarded.

Weak flow at faucets is often caused by small or clogged distribution pipes. In general, branches longer than 25 feet or supplying two or more small fixtures should be of ¾-inch pipe. Table 6 indicates sizes of distribution pipes in general use.

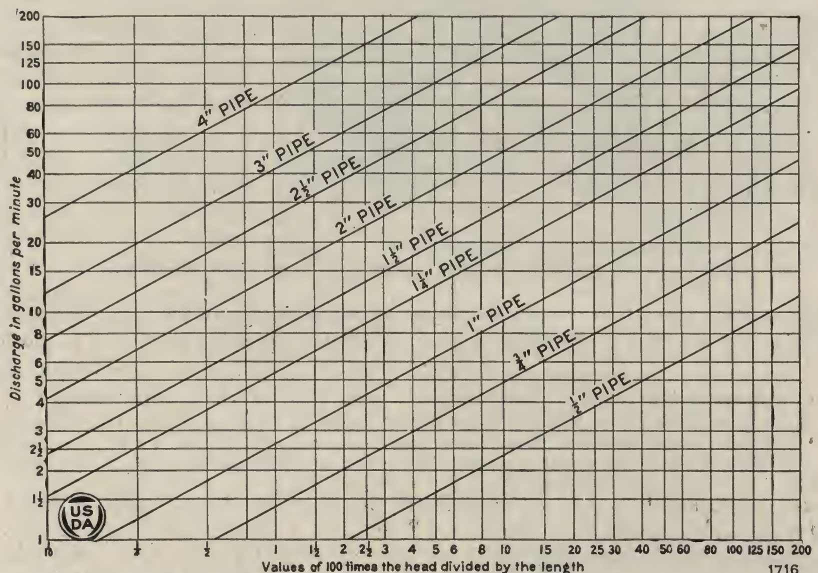

FIGURE 4.—Diagram giving the discharge of long straight water pipes, ½ to 4 inches in diameter.

Directions: Measure the head or vertical height in feet from the delivery end of the pipe to the surface of the water in the spring or tank; multiply this head by 100 and divide the product by the actual length of the pipe in feet; find this value on the lower horizontal line of the diagram and follow vertically upward to the inclined line or lines showing pipe sizes; from such intersection follow horizontally to the left to find the discharge in gallons per minute. Example: How much water will be discharged by 128 feet of 1-inch pipe under a head of 32 feet? Solution: Thirty-two multiplied by 100 equals 3,200; 3,200 divided by 128 equals 25; enter the diagram at 25, follow upward to the line marked 1-inch pipe, and then follow to the left where the discharge is seen to be 15 gallons per minute.

TABLE 6.—*Sizes of house distribution pipes (inches)*

Class of pressure	Distribution main	Short branch to—						
		Bathroom	Bathtub	Washstand [1]	Closet tank [2]	Kitchen sink	Laundry	Sill cock
High	¾	¾	½	½	½	½	½	½
Medium	¾ or 1	¾	½	½	½	½ or ¾	½ or ¾	¾
Low	1 or 1¼	¾ or 1	½	½	½	¾	¾	¾

[1] Pipe from floor or wall is usually ⅜ or ½ inch, reducing to ¼-inch at faucet tailpiece.
[2] Pipe from floor or wall to ball cock is usually ⅜-inch.

DRAINAGE AND VENT PIPES

Although the requirements of local plumbing codes differ greatly, there is a growing tendency toward standardization, and in the absence of code requirement it is believed the following tabulation lists the sizes of soil, waste, flush, and vent pipes that are serviceable and safe in ordinary farm homes.

Pipe and conditions	*Size (inches)*
House drain; ordinary house, no rain water	4
Soil stack	3
Water-closet bend and branch to soil stack	[1] 3 or 4
Water-closet flush, low tank, O.D.[2] tubing	2
Waste; lateral pitched ¼ inch per foot, and including fixture pipe or O.D. tubing to wall or floor:	
Kitchen sink, bathtub, washstand,[3] laundry tub (1, 2, or 3 section) with continuous waste and trap, or combination sink and laundry tub (1 or 2 section) with continuous waste and trap, each fixture	1½
Two washstands	1½
Three washstands or any two of the other fixtures	2
Slop sink, shower stall, floor drain, or kitchen sink waste buried in ground or concrete	2 or 3
Waste stack; usually same size as largest lateral draining into it	1½ or 2
Traps; no smaller than entering waste; minimum seal, 2 inches:	
Vents:	
Extension of soil stack	3
One washstand [3] on a 1¼-inch stack	1¼
Two or three small fixtures on a 1½-inch stack	1½
Up to 6 small fixtures on a 2-inch stack	1½
Water closet (if another is above) with the usual small fixtures	1½ or 2

FITTINGS

Fittings and pipe should be of similar metal—cast iron with cast iron, malleable iron with wrought iron or steel, and brass with brass or copper pipe. Plain galvanized malleable-iron fittings are suitable for low-pressure indoor wrought water pipe, but the stronger banded fittings are generally used for high pressures and underground work.

Figure 5 shows cast-iron drainage fittings which avoid abrupt changes of direction. Those for wrought pipe are galvanized or asphalted, and have enlarged ends forming a recess about three-fourths inch deep. They have the same bore as standard pipe (I.P.S.), which, when screwed in, butts against the shoulder, forming a smooth and continuous waterway.

JOINTS AND CONNECTIONS

Joints require special care because trouble is likely to occur first in them. Several kinds of prepared joints are shown in figure 3. Making these joints requires clean bearing surfaces and good use of calking tools or a ratchet or monkey wrench.

Wrought, brass, or copper pipe (I.P.S.) is cut with a hack saw or a wheel or knife pipe cutter. Steel dies for cutting threads should be sharp. Lard oil or other suitable lubricant should be applied to the cutting as soon as the die catches, otherwise the thread will be poor and the die may be spoiled. A lubricant is less necessary on brass-pipe threads and some plumbers use soapy water.

[1] The smaller size is favored, although 4-inch is common.
[2] "O.D." means outside diameter.
[3] Washstand wastes are generally 1¼-inch, but 1½-inch is considered preferably.

The die stock is turned until the end of the pipe is flush with the face of the die or projects one half thread. Further threading is not only useless but may be a hindrance in making up good joints. Seven or eight effective taper threads are cut and about half of these may be run by hand into a well-threaded fitting or valve. Tightness is secured by turning the last three or four threads with a pipe wrench. Few or no threads should show outside the fitting (fig. 3, A). Exposed threads weaken the pipe and hasten corrosion; they should be painted with black asphaltum. When making up screw joints the male thread is generally painted with a commercial paste lubricant and joint filler, or with a homemade paste of graphite or red lead mixed with boiled linseed oil, or of litharge and glycerin.

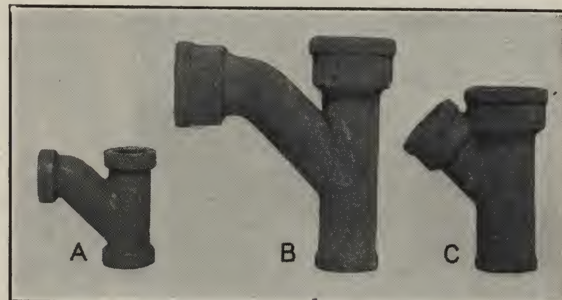

FIGURE 5.—Important drainage fittings: A, 90° long turn TY-branch recessed and threaded for wrought pipe; B, combination Y and eighth bend for calking; C, 45° Y-branch for calking.

Copper service tubing is cut with a hack saw and the ends are joined with unions (fig. 3, C) or threadless fittings as shown in figure 3, D.

Cast-iron water and soil pipes are cut with a blacksmith's cold chisel, a hand cold chisel as shown in figure 6, or a suitable wheel cutter. The pipe should be lightly scored or grooved squarely around with a chisel or file. It is then rolled on a 2 by 4 inch strip laid flat and increasingly heavy blows are struck as the chisel cuts deeper. An even break is usually obtained after circling the pipe several times.


FIGURE 6.—Cutting cast-iron pipe with a cold chisel.

Bell (or hub) and spigot joints are made by ramming, with a yarning iron, a strand of packing into the bottom of the joint space, filling at one pouring with molten pig lead as shown in figure 7, and driving with a hammer and calking tools as shown in figure 8. Rope oakum or twisted jute is used in cast-iron soil pipe, leaving about 1 inch for lead, one half to three fourths of a pound of which is required per inch of pipe bore. Dry, untarred, twisted or braided jute or hemp is used in cast-iron water pipe, leaving about 2 inches for lead, about 1¾ pounds of which are required per inch of pipe bore. With a calk-

ing tool pointed about one fourth by three fourth inch, the joint is gently driven all around several times. This avoids splitting the hub and evenly compacts the lead. The next driving is harder and the joint is smoothly finished with the calking tool that most nearly fits the space without binding. Instead of melting lead it is sometimes very convenient to use a good commercial jointing compound that requires no calking, or lead wool in loose rope form, calked cold.

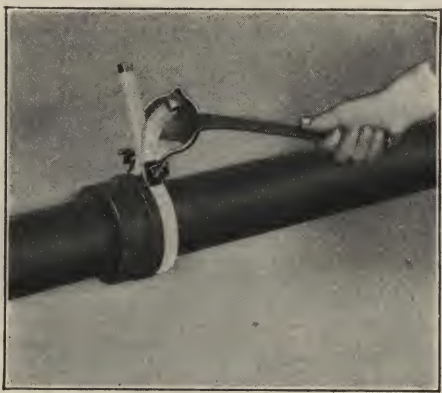

FIGURE 7.—Horizontal pipe line: Use of an asbestos pipe jointer clamped at the top and firmly pressed against the hub to prevent escape of the molted lead.

It is often necessary to join different kinds of pipe or make some special connection. Figure 9 shows some of the more common types of joint and figure 10 shows typical water-closet connections. The lead and putty closet connection is very simple and when well made has given excellent satisfaction for many years, but is prohibited by some plumbing codes. The lead bend is beaten out with a hammer to form a flange flat on the floor. The flattened end and the entire bottom of the bowl are smeared with red lead. About 2 pounds of putty are spread over the bottom of the bowl using care to more than fill the circular space around the horn. The bowl is then set in position and heavily pressed, first on one side and then on the other, to obtain a full, even bed of putty under the whole bottom. This work is best done while standing astride of and facing the rear of the bowl. When well bedded the bowl is tightly screwed to the floor.

FIGURE 8.—Calking a lead joint to make it air-tight and water-tight.

LOCATING AND ROUGHING-IN PLUMBING

A plan or sketch showing pipe sizes and arrangement of fixtures should be made before the work is begun. Houses of simple design make possible simple, compact, inexpensive plumbing. Every bathroom should have a window, skylight, or ventilating duct to the outer air. Placing the fixtures along one wall saves pipe. Figure 11 shows typical bathrooms for small and medium-sized houses.

In new houses the pipes that will be concealed should go in after the framing is erected or during its erection. In old houses it is equally important to know how pipes must run to meet fixture open-

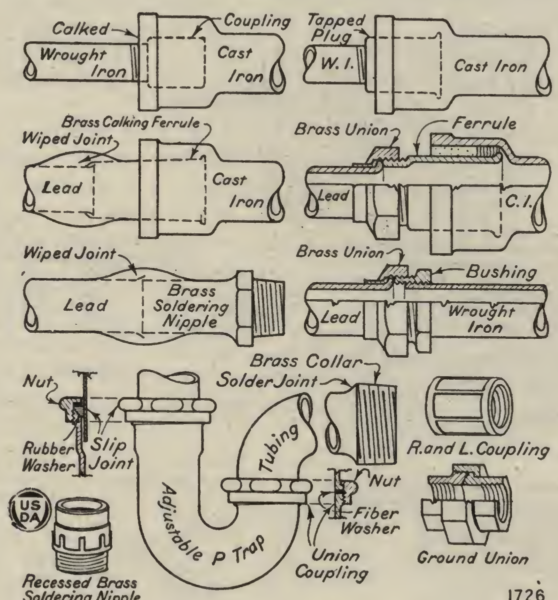

FIGURE 9.—Methods of joining different kinds of pipe.

ings. Roughing-in is the installing of the pipes to floor and wall lines. Manufacturers of fixtures prepare roughing-in measurements of their products. There are no fixed standards, though the varia-

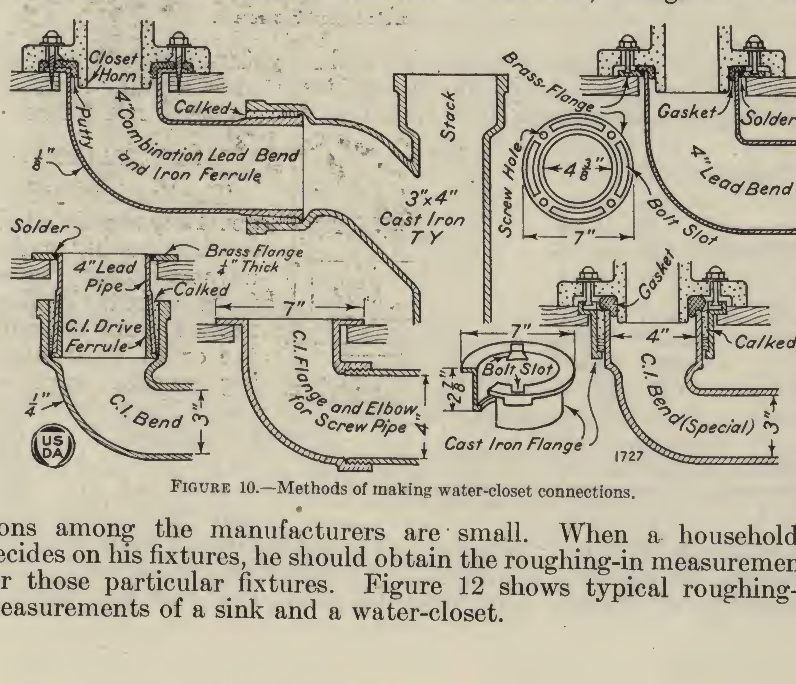

FIGURE 10.—Methods of making water-closet connections.

tions among the manufacturers are small. When a householder decides on his fixtures, he should obtain the roughing-in measurements for those particular fixtures. Figure 12 shows typical roughing-in measurements of a sink and a water-closet.

The house drain is generally installed first and the soil stack is carried upward from it. The fittings for branches should be assembled in correct position and the length of the pipe to be cut to fit should

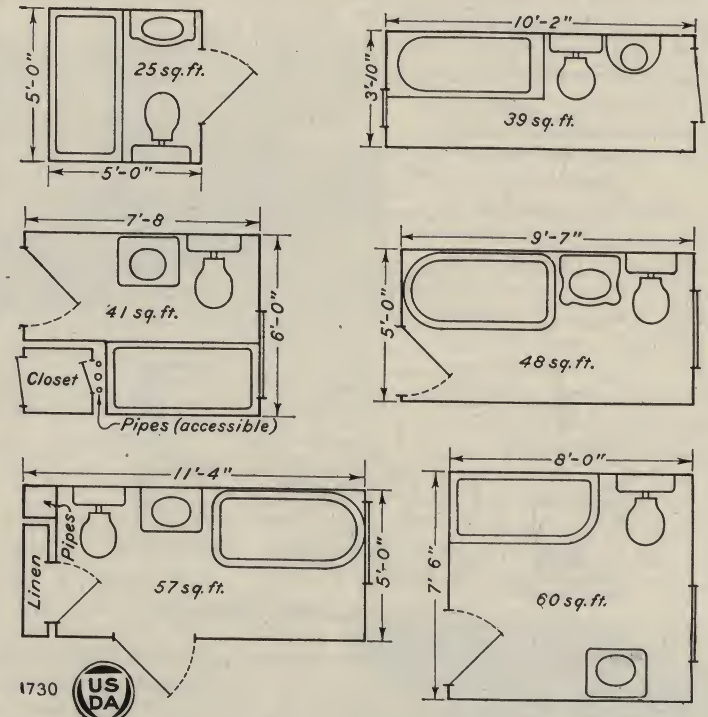

FIGURE 11.—Floor plans of six typical bathrooms.

be measured. Methods of supporting and roughing-in pipes are shown in figures 13 and 14. All piping (except traps) should grade to drain, thus avoiding sags or pockets in which water can stand and freeze.

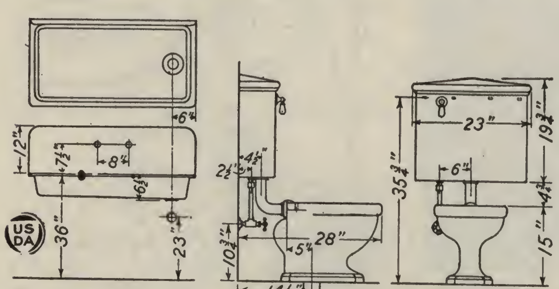

FIGURE 12.—Typical roughing-in measurements of a flat-rim kitchen sink with detachable back and a reversed-trap, siphon-action water-closet: The distances are not fixed standards, but are merely illustrative of particular types of fixtures from one manufacturer.

HOT WATER

The heating element generally used is a hollow iron casting, called a water back or water front, set in the kitchen range fire box opposite the oven. The heating surface approximates 2½ square inches per gallon of boiler capacity. It has walls about one half inch thick with two tappings for ¾- or 1-inch pipe. The lower tapping (inlet) and the upper tapping (outlet) are piped to low and high connections in the side of a range boiler. The operating principle is that hot water is

lighter than cold water and rises: the cold water sinks to occupy its place, thus creating circulation. The hot water pipe should be pitched upward throughout its whole length; humps or air pockets must be avoided.

Figure 15 shows a simple, home-made heating element or coil in a wood-burning stove in a dairy wash room. Four pieces of 1-inch black wrought pipe about 2 feet long made into three loops are connected to a galvanized-steel gasoline barrel. The barrel is filled with cold water poured in from a pail at the top and hot water is drawn at the faucet.

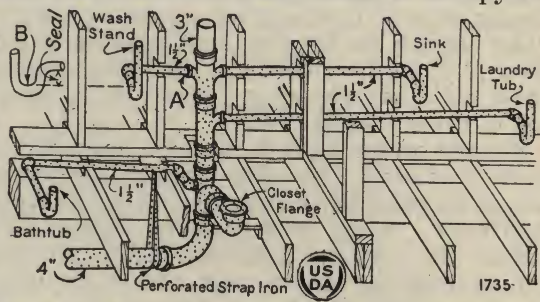

FIGURE 13.—Supporting and roughing-in a simple, 1-pipe system—a very economical method for bungalows and cottages with fixtures on one floor and near the soil stack. Note three points: (1) There are no back vents; (2) all small waste pipes enter the stack at or above the side inlet of the "crowfoot" fitting serving the closet branch, thus preventing the water-closet from siphoning the small traps; (3) in no instance is the inside bottom of the waste pipe at the stack (point A) lower than the dip of the trap (point B), thus preventing self-siphonage of the trap; this provision limits the length of the waste; for example if the trap seal is 2 inches and the slope of the waste is one-fourth inch per foot, its length should not exceed 8 feet (2 divided by ¼ equals 8) and less would be better.

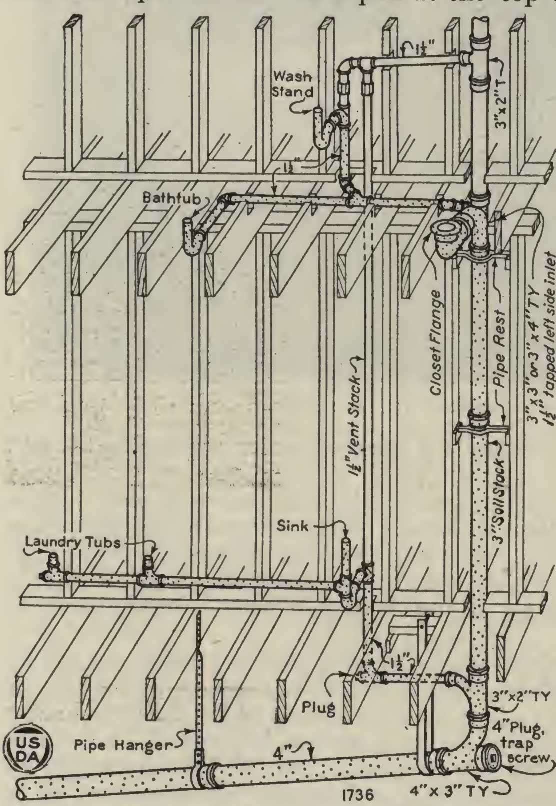

FIGURE 14.—Supporting and roughing-in a simple 2-pipe system having continuous wastes and vents; the most effective way of venting traps. Drainage pipes are stippled and vent pipes are outlined.

Kerosene and gasoline tank heaters of various sizes are sold at from $14 to $20 and up. Coal-burning cast-iron laundry-tank heaters with fire-clay-lined fire boxes are available in various sizes and cost from $8 or $10 up. Figure 16 shows a laundry heater and kitchen range connected to a boiler, thus making use of either or both sources of heat. Figure 17 shows a combined coal-burning heater and storage tank with automatic temperature control. Figure 18 indicates the essentials of a simple installation for steam circulation where large quantities of stored hot water are required.

Where gas is available a gas heater, used

alone or with other methods of heating, is very convenient. A heater costing $6 to $10 and in good operating condition will give enough hot water for dish washing in 5 to 8 minutes or for a bath in 15 to 20 minutes. Figure 19 shows a range boiler connected to a gas heater, a water back, and a heating element in a furnace, thus making use of any of three sources of heat.

Electric water heaters may be equipped for either hand or automatic operation. Suitable temperature control and a sealed "time" switch are generally necessary in order to obtain the low night rates on electricity. A fair average daily allowance for hot water (150°) is 7 gallons per person. The capacity of an electric heater, with a 90° temperature rise in the water, should approximate 4 gallons per kilowatt hour. On this basis, with current costing 2 cents per kilowatt

FIGURE 15.—Home-made hot-water installation.

hour, the yearly cost of energy for heating water approximates $13 per person.

Where either electricity or gas is available a combined heater and insulated storage tank equipped with automatic temperature control is very desirable. The consumption of electricity or gas (small pilot flame excepted), when no hot water is being used, is merely that required in overcoming radiation loss, which in well-insulated tanks is small.

It is sometimes desired to obtain most of the hot water in winter from a steam-heating plant and to meet emergency and summer demands by other means. This may be done with an indirect heater connected, as shown in figure 20, to a steam boiler and to a range boiler heated with an ordinary kerosene heater. In place of the latter a gas, electric, or coal-burning tank heater, either automatic or hand controlled, can be used if desired. The indirect heater is usually

set alongside the steam boiler and below its water line. Hot water from the steam boiler circulates through the cast-iron jacket, imparts heat to the water in the copper coil, and returns to the boiler. The domestic supply heated in the coil circulates in the usual way through the range boiler. An ordinary indirect heater for a 30- or 40-gallon range boiler costs $3 to $8. It does not heat the tank water to the boiling point and does not interfere with combustion and firing operations. The gate valve should be closed during summer operation to prevent circulation through the steam boiler and consequent loss of heat.

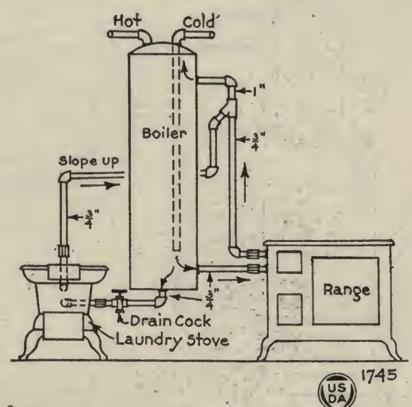

FIGURE 16.—Boiler connected with a kitchen range and a laundry stove.

Many persons believe that the domestic hot-water supply can be obtained from a house heating plant without increased cost for fuel. This is erroneous, because the effect is that of adding radiation to the boiler. Considerable heat can be saved by covering boilers, tanks, circulation pipes, and frequently used hot-water lines with good commercial insulation ½ to 1 inch thick.

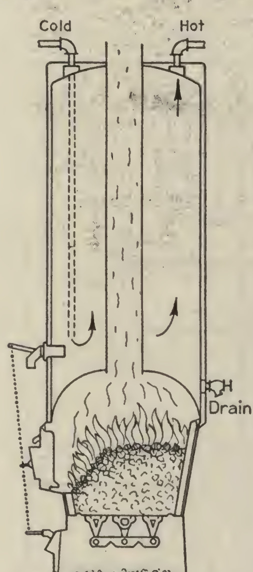

FIGURE 17.—A combined solid-fuel heater and enameled metal-jacketed galvanized-steel storage tank with automatic temperature control of check and ash-pit dampers.

Range boilers are made of steel or copper and in weights or strengths to conform with the water pressure. A standard-weight, welded and riveted, galvanized-steel boiler 12 by 60 inches, holding 30 gallons, and suitable for 85 pounds working pressure, costs, complete, $10. The same size in copper costs $30 to $35, but lasts longer and imparts no rust to the water. Galvanized boilers tapped standard have five 1-inch (I.P.S.) tappings—two in the top, one in the bottom, and two in the side. The pipes between the water back and boiler are generally three-quarter inch and preferably of brass. Connections with the boiler are made with boiler couplings or elbows as shown in figure 21. Union-type fittings add little to the cost and much to the convenience if it becomes necessary to disconnect a boiler. Copper boilers usually come with fittings inserted.

Figure 21 shows four ways of connecting range boilers and water backs; the advantages of each method are indicated in the legend. To prevent mixing the cold and hot water, the cold-water pipe is extended inside the boiler as shown. This inner pipe is generally three-fourths inch, should have a ⅛-inch air hole tapped near its top to prevent siphonage, and should end at the level of the top of the water back. To lessen corrosion and trouble

with rust it should be of brass or copper; it is readily inserted in the boiler by first screwing it into the ¾-inch female thread of the fitting and then screwing the fitting's 1-inch male thread into the boiler tapping. Where the pressure is high, permitting the use of a small inner pipe, the two female threads may be one-half inch.

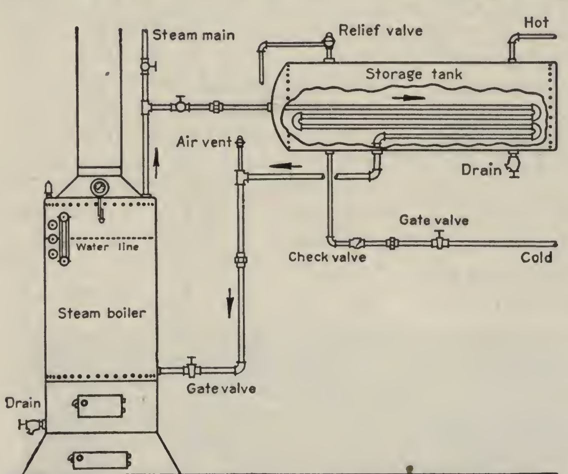

FIGURE 18.—A steam boiler connected to circulate steam through a pipe coil in a storage tank.

Caution: Serious steam-boiler and range-boiler explosions have occurred because expansion of the steam or hot water was prevented. Merely warming cold water a few degrees in a confined space creates high pressure and may cause damage. This situation may result from: (1) Frozen or scale-bound pipes; (2) thoughtlessly closing a valve on the service or cold-water branch that feeds a boiler; (3) using a check valve or a pressure regulator on the service or branch; or (4) the sticking of a relief valve because of corrosion or disuse.

The remedies for these conditions are: (1) Lay the service pipe below frost or otherwise protect it and never allow the house temperature to fall much below freezing; if frozen pipes are suspected, open the cold-water faucet at the kitchen sink to see if the service and branch are free; unless there is conclusive evidence that all lines are free, do not start the range fire or heater until the water back or coil, the circulation piping to the boiler, and the cold-water line which feeds the boiler have all been thawed; information on thawing frozen pipes and removing scale from water backs and connections is given in Farmers' Bulletin 1460, Simple Plumbing Repairs in the Home. (2) When a range or other heater is in operation never close a valve which, for control or repair purposes, may have been set in the service or branch that feeds a boiler. (3) If a check valve is installed on a metered service to

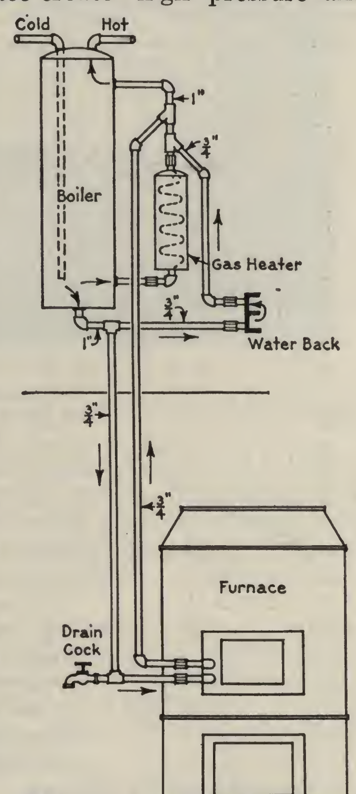

FIGURE 19.—Boiler connected with a kitchen range, a gas heater, and a furnace.

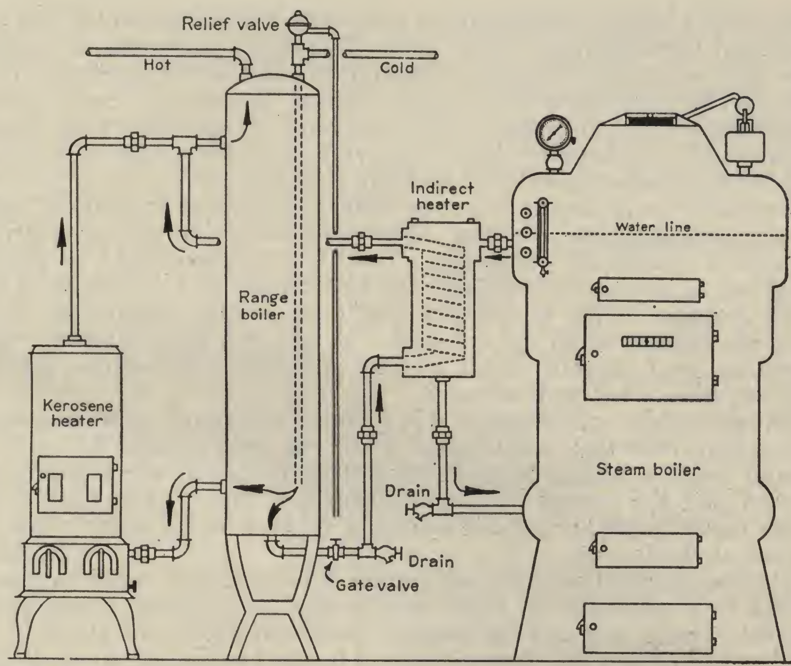

FIGURE 20.—Steam-heating boiler connected to circulate boiler water through an indirect heater, inducing circulation in a range boiler; the kerosene heater connected directly to the range boiler is for summer or emergency use.

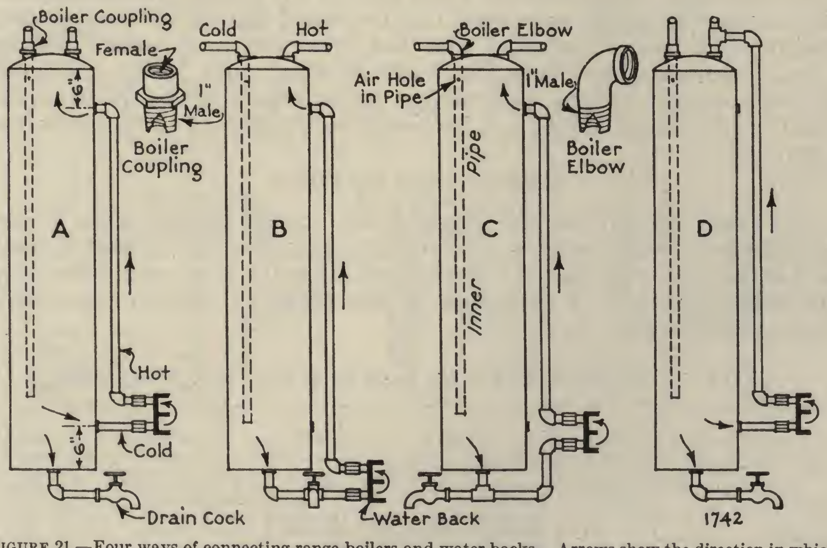

FIGURE 21.—Four ways of connecting range boilers and water backs. Arrows show the direction in which the water moves. A, Standard tappings; short, direct connections; excellent for either water back or gas heater; has ample space in which sediment may settle below the line of circulation; occasionally a pail of water should be drawn off at the drain cock. B, Cold-water circulation pipe from bottom of boiler. C, A common method where the height of the boiler stand does not permit the straight connection shown in A and B. D, Connection just above the boiler; often used with a gas heater because small quantities of hot water can be drawn in a minute or two after lighting the gas. This connection is not so satisfactory as A, B, or C because circulation and equalization of temperature are not so good

prevent hot water backing up to the meter, the range boiler can be protected by attaching a relief valve, frequently examined to make sure that sticking has not rendered it useless, or by placing a by-pass having a reversed check valve around the meter. Some manufacturers of copper range boilers regularly equip them with relief valves, and such a valve should always be installed if the water system has a pressure regulator or pressure-reducing valve.

Rumbling or pounding in range boilers, chattering in faucets, and knocking in pipes are annoying; they show faulty but not necessarily dangerous conditions. Sometimes there is a snapping noise or slight rumbling in a range boiler. This is due mainly to the formation of steam bubbles in the water back and their sudden collapse as they enter the cooler water in the tank. A hot fire may intensify the rumbling until it seems like a violent pounding. Sometimes steam sputters from a hot-water faucet.

These troubles are generally due to slow, air-bound, or overheated circulation, defective faucets, and water hammer caused by quick-closing faucets. Little apprehension need be felt if the equipment is good and the heated water can expand. When the bottom of a range boiler is hot, it is poor economy to heat water faster than it is used at the faucets.

A water back should be set exactly level and the upper tapping should be flush with the inside top so that the hottest water may circulate freely and not be trapped and converted into steam. A fire-box coil or pipe fold (fig. 15) should be level or, better, so made up that there is continual rise from cold-water inlet to hot-water outlet. Circulation is frequently improved by using larger or better-pitched hot-water pipe from the coil or water back to the boiler. It is of greatest importance to avoid any trap or downward dip in this connection. Steam at a faucet indicates that the boiler water is above boiling temperature and not that the boiler is filled with steam. Faucet washers, stems, and packing should be in repair (Farmers' Bulletin 1460) and faucets should not be closed so quickly as to create water hammer.

PROTECTION OF PIPES

All pipes should be safe from frost. Small water pipes freeze quicker than waste pipes and sewers in which the flow is intermittent and somewhat warmed. Latitude and soil and cover conditions vary the depth of frost. A fair guide to the depth at which to lay small water pipes is given in table 7.

TABLE 7.—*Depths at which to lay small water pipes in different States*

State	Depth	State	Depth	State	Depth
	Feet		*Feet*		*Feet*
Alabama	1½ to 2	Kentucky	2 to 3½	New Mexico	2 to 3
Arkansas	1½ to 3	Louisiana	1½ to 2	New York	4 to 6
California	2 to 4	Maine	4½ to 6	North Carolina	2 to 3
Colorado	3 to 5	Massachusetts	4 to 6	North Dakota	5 to 9
Connecticut	4 to 5	Michigan	4 to 7	Ohio	3½ to 5½
Florida	1 to 2	Minnesota	5 to 9	Pennsylvania	3½ to 5½
Georgia	1½ to 2	Mississippi	1½ to 2½	Tennessee	2 to 3
Idaho	4 to 6	Missouri	3 to 5	Texas	1½ to 3
Illinois	3½ to 6	Montana	5 to 7	Virginia	2 to 3½
Indiana	3½ to 5½	Nebraska	4 to 5½	Wisconsin	5 to 7
Iowa	5 to 6	New Hampshire	4 to 6	Wyoming	5 to 6
Kansas	2½ to 4½	New Jersey	3½ to 4½	District of Columbia	4

Where pipes are liable to freeze they may be covered with a box that will shed water and surrounded with dry shavings, excelsior, sawdust, leaves, chopped straw, charcoal, granulated cork, pea or nut size coke, or mineral wool. Within a building it is more convenient to use a commercial covering of wool felt or hair felt. These coverings come in 3-foot lengths, in sizes to fit different pipes and fittings. They are split on one or both sides to slip over the pipe and are fastened with wires or brass bands. Figure 22 shows two widely used kinds. The wool felt covering for ¾-inch pipe costs about 12 cents per foot. These coverings are sometimes used to deaden sound and to do away with condensation of moisture and drip from exposed overhead pipes. A good homemade covering is a tar-paper lining with a wrapping of felt, the whole jacketed with canvas pasted or wired on and finished with a good waterproof paint.

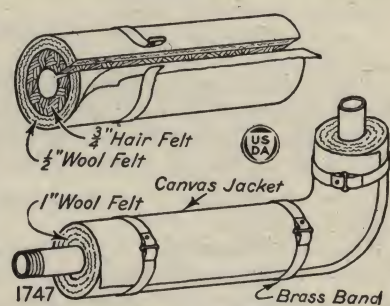

FIGURE 22.—Two pipe coverings for protecting indoor water pipes from frost

The insulating material for hot-water pipes and range boilers may be asbestos, magnesia, or plaster of Paris. Cork, hair felt, or wool felt lined with asbestos paper are effective.

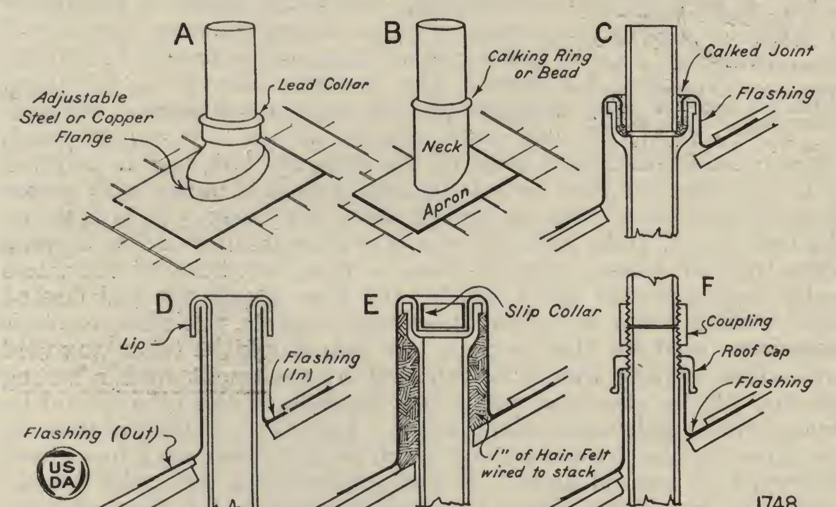

FIGURE 23.—Six weather-tight roof connections: A, B, and D, simple commercial products adapted to pitched or flat roofs; B, 1-piece all-lead flange; D, a cast-iron pipe with extended lip covering the top of the flashing; C, ordinary cast-iron soil pipe with a flashing bent over and calked into the hub; E, a good method of protecting a stack to prevent closure by frost; F, a substantial screw-pipe roof connection.

ROOF CONNECTIONS

Every pipe that passes through a roof should have a lead, copper or galvanized roofing flange. Figure 23 shows six different forms. The apron of the flange is flashed into the roofing and the neck is made water-tight to the pipe 6 to 12 inches above the roof slope. The pipe is usually extended 12 to 18 inches above the roof, the shorter distance being preferable in very cold climates where the

pipe may be closed by frost. To lessen liability of closure, the pipe from a foot below the roof to the top is sometimes made one or two sizes larger or is insulated as shown in figure 23, E. Lead flanges are about 15 inches square, one sixteenth inch thick, and weigh 4 pounds per square foot. Soft copper flashing is usually one fiftieth inch thick and weighs 1 pound per square foot. Galvanized flashing usually approximates the same thickness.

FLOOR DRAINS

Floor drains are seldon installed unless to meet actual need and frequent use, as in a creamery, cannery, slaughterhouse, pump room, or garage. If a drain is needed a simple deep-seal trap of the type shown in figure 24 is desirable.

CARE OF PLUMBING

Good, well-cared-for plumbing causes little trouble or expense. Frozen water pipes are frequently the result of insufficient protection or a willingness to take chances with the weather. Newspaper, rags, garbage, or other matter that may obstruct traps and pipes or prove detrimental in cesspools, septic tanks, or sewers should never be thrown into water closets. Grease and fats should not be wasted through sink outlets.

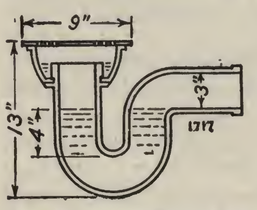

FIGURE 24.—A typical floor drain and trap with 4-inch water seal.

Obstructing matter in traps is sometimes removed with a strong caustic solvent, of which numerous inexpensive brands are on the market. The maker's directions for using them are printed on the containers. Caustic soda and caustic potash are widely used. Caustic soda constitutes most of the ordinary lyes and is believed to be less effective than caustic potash because it unites with grease to form hard soap, whereas potash forms soft soap. It is believed the best use of drain pipe solvents is as an occasional aid in keeping traps free and clean. Several times a year, or whenever the waste water begins to run away slowly, the pipe should be well flushed with boiling water to soften the greasy matter. A blow torch is sometimes used for this purpose, but care should be taken to avoid fire. This heating should be followed by treatment with a strong solution of the chemical, and a half hour later the pipe should be flushed thoroughly with boiling water. Little or no injury is done to the pipes by this treatment and much of the grease may have been destroyed or washed away. If not successful at first, the process should be repeated. These chemicals generate much heat, and are therefore useful in thawing frozen pipes. They should be kept where children cannot get them.

Fixtures should be cleaned daily. No sharp or pointed utensil, sandpaper, coarse or gritty powder, scouring soap, oil, acid, or acid preparation should be used, because they tend to injure the thin, shiny glaze, literally the skin of enameled and vitreous wares. Repeated applications of lemon juice and salt, often used by housewives to remove iron rust from enameled ware, have sometimes proved injurious. Fixtures should be treated much the same as table crockery, mainly with soap and hot water. A very fine, spe-

cially prepared cleaning powder costing 25 cents per can may be used as needed to remove grime and stains. A small quantity of the powder should be sifted on a damp cloth and the fixture wiped out or lightly scoured and rinsed with clean, warm water. A little kerosene on a cloth may be used to remove paint and grease. Soap, water, and a brush are ordinarily sufficient for cleaning water closets. If a vitreous bowl has become badly discolored and foul smelling, a small quantity of chemical closet cleaner may be sifted into the water in the trap, allowed to stand several hours, and then flushed away.

Pipes, traps, and tanks in houses unoccupied in cold weather should be drained and the traps should be filled with an antifreezing liquid or semiliquid. Water pipes are drained by closing the stop and waste cock at the cellar wall, opening the lowest fixture faucet to allow most of the water to waste into the house drain, and opening the highest faucet to admit air. Unscrewing a trap clean out drains it quickly; and traps without a clean out can usually be drained with a syringe and piece of rubber tubing. Removing the water below the jet opening of siphon-jet bowls should not be forgotten.

Among antifreezing substances used in traps are: A 40 percent solution of glycerin (2 volumes) in water (3 volumes); a 66⅔ percent solution of low-grade honey (2 volumes) in water (1 volume); thin low-grade sirup or molasses; a 33⅓ percent solution of wood alcohol or denatured alcohol (1 volume) in water (2 volumes); a strong brine made by dissolving 2½ to 3 pounds of common salt or calcium chloride in 1 gallon of water (cheap, but tends to corrode metals); kerosene (good, but "weeping" at a trap joint may stain a floor or ceiling); low-grade lubricating or vegetable oil. Most of these substances are suitable for temperatures near zero, some evaporate more rapidly than others, and most of them are only slightly corrosive.

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